Fiber Optic Accelerometer

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Miniature accelerometers are broadly useful instrumentation sensors for mechanical systems. Weapons testing needs very small, preferably passive, accelerometers. We have built a 200-g accelerometer, with a footprint of just 4.5 mm x 7 mm, using a fiber optic interferometer readout of proof mass position.

Most commercial devices are large and have electrical power and signal readout; often this is a small signal and the electrical wiring is a hazard in explosive environments.

We have built a 3.5-kHz resonant frequency, 200-g MEMS sensor, using bulk wafer RIE machining, and epoxy packaging. A wafer yield is about 100 parts. The proof mass moves laterally and forms the moving mirror of a Fabry-Perot cavity. The fixed mirror is provided by an optical fiber that is packaged into the 150-µm-square groove in a 400-µm-thick wafer, shown on the right in Fig. 1.

Figure 2 shows the silicon part, epoxy bonded between two glass plates.

The heart of any accelerometer is the proof mass and spring combination (Fig. 3); the resonant frequency determines the bandwidth and the sensitivity of the accelerometer. By adjusting the tether spring thickness a few micrometers with processing, the response of this device can be tuned from about 10 g to 1000 g. Initial testing shows the DC response to be 37 nm/g with 23-µm tethers. A more robust fusion bonded package is desirable for temperature range and stability.

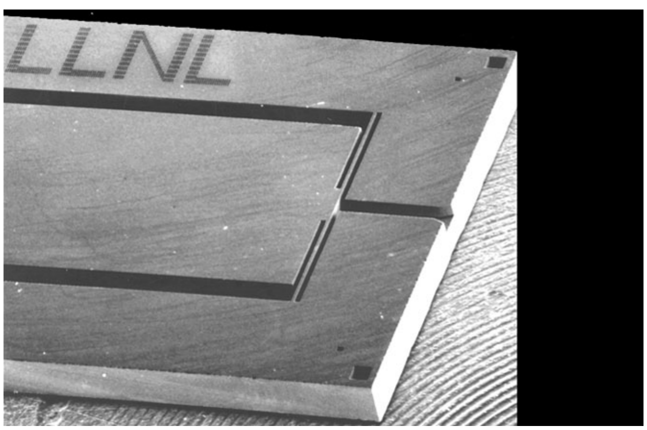

Figure 1. *Key component: the silicon proof mass, with 2 of 4 tethers, 1 mm long, in the frame shown.*

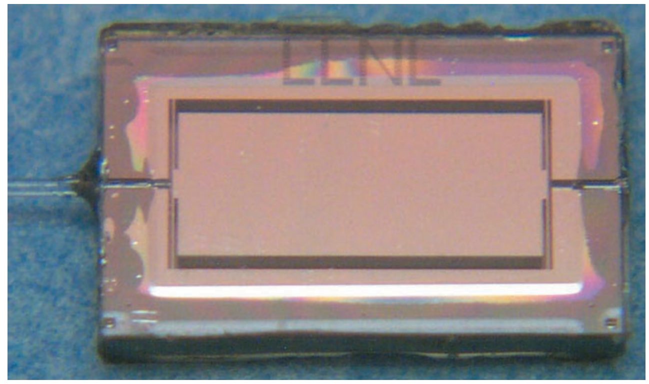

Figure 2. *Silicon part, epoxy bonded between two glass plases, with a multimode optical fiber, to complete the 200-g, 4.5-mm-x-7-mm MEMS accelerometer sensor.*

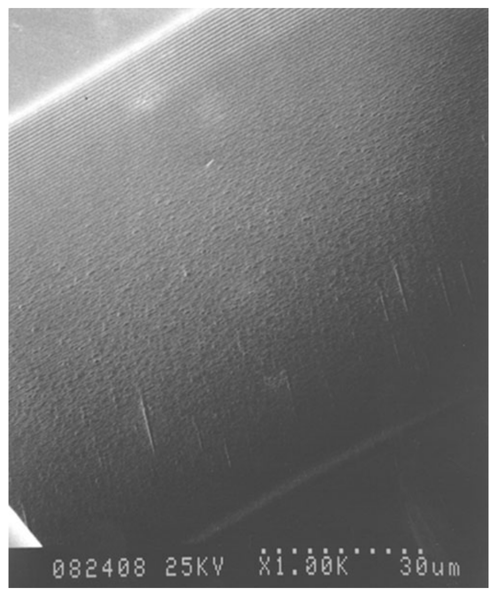

Figure 3. *Silicon proof mass mirror, RIE etched sidewall, smooth enough for the white light interferometer and multimode fiber readout.*